Spacecraft Fire Safety

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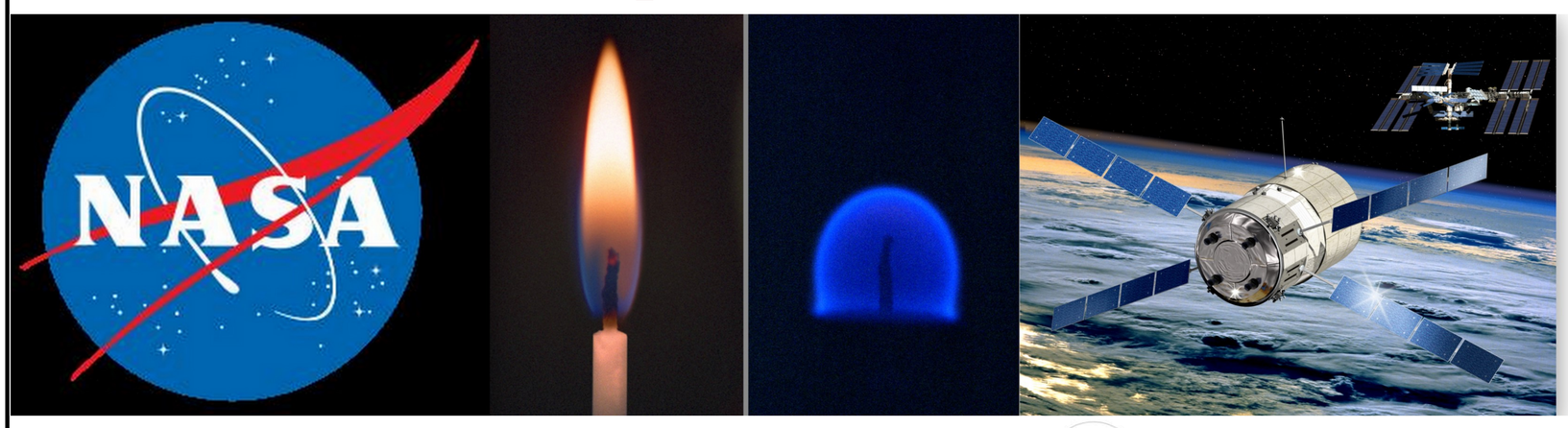

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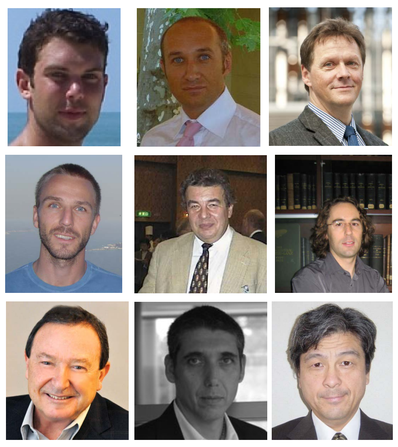
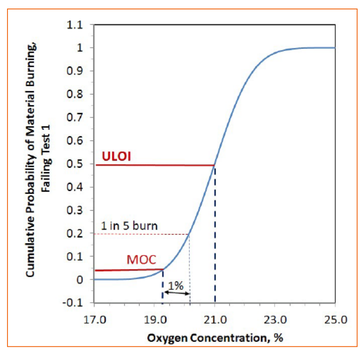
International Topical Team Formed

Spacecraft Fire Safety is a project run by scientists from NASA and ESA, plus a **group of international scientists (pictures below)**, that aims to revolutionize spacecraft fire safety designs for next-generation space vehicles and habitats. It will feature a validation experiment on an unmanned but pressurized vehicle such as the ESA Automated Transfer Vehicle (ATV) after it has completed its supply mission to the International Space Station.

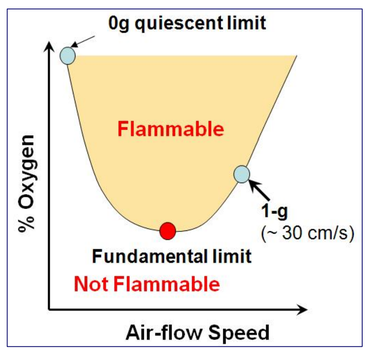


Problem Identification

Full scale fire testing complemented by computer modeling has provided significant knowhow about the risk, prevention and suppression of fire in terrestrial systems (cars, ships, planes, buildings, mines, and tunnels). In comparison, no such testing has been carried out for manned spacecraft due to the complexity, cost and risk associated with operating a **material flammability experiment of a relevant size and duration in microgravity**. Therefore, there is currently a gap in knowledge of fire behavior in spacecraft.

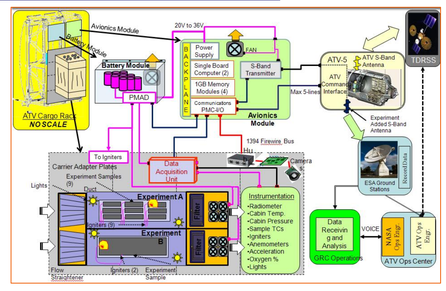


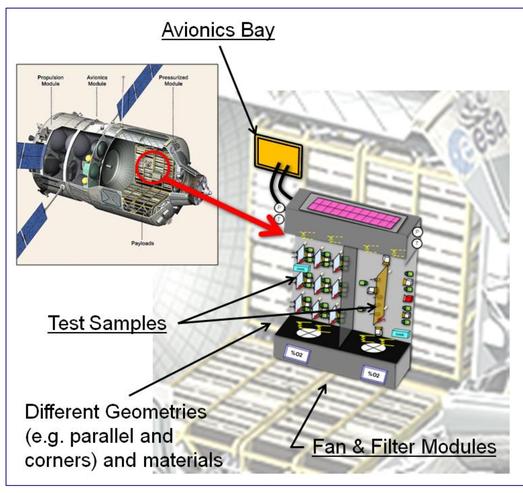
NASA Test1 challenges



Flammability limits differ

Vessel Identification



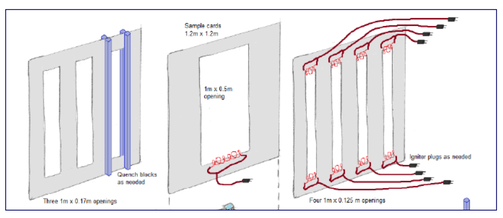


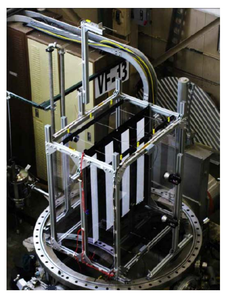
Diagnostic Equipment:
- Accelerometers
- Anemometers
- Lights
- Cameras
- Radiometers
- Pressure Sensor
- Temperature Sensor
- Oxygen Concentration
- Fire Detection Sensors
  - –Gaseous
  - –Particulate

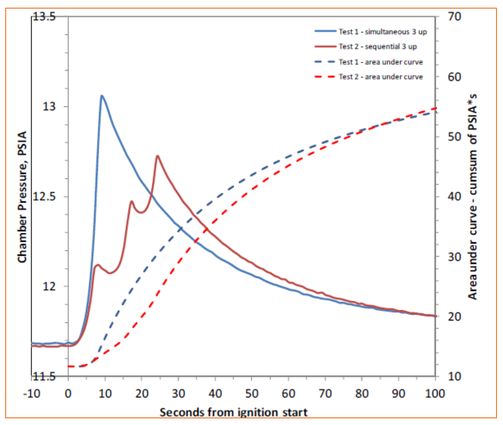
Experiment Equipment:
- Fans
- Support Plate
- Smoke Cleaning Material
- Protection Screen
- Ignition System
- Test Material
- Extinguishing Agent
- Command, Control, and Data Computer
- Communication Link (antenna, wiring, interfaces)

Overpressure Testing and Modeling

The experiment will need to meet rigorous safety requirements to ensure the carrier vehicle does not sustain damage

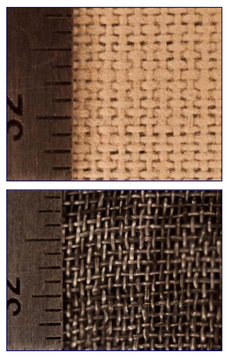




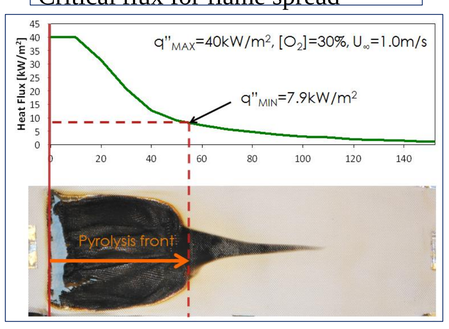


Ground Experiments

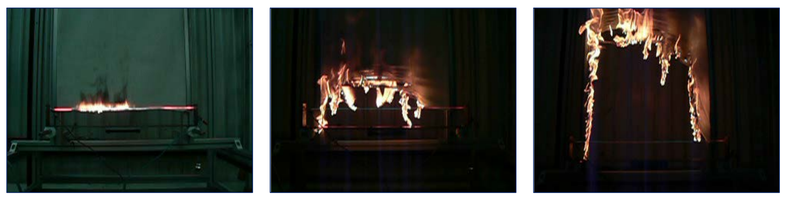
SIBAL before and after test



Critical flux for flame spread

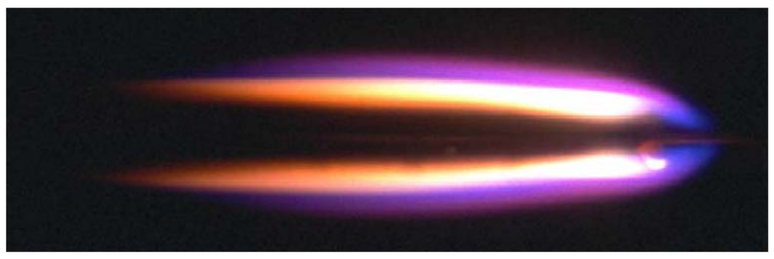


Soot measurements in flame (backlighting technique)



ISS Experiments

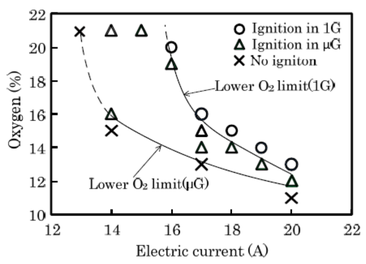
Microgravity Sciences Glove (MSG) Box tests conducted



Parabolic Flight Experiments

Team members have significant experience with parabolic flights and more experiments will be conducted.

Drop Tower Experiments



Validation Experiment

It is important to emphasize that the experiments on the identified vessel will be validation experiments, not data mining experiments. As such, the other experiments will guide the design. Further, the sensor density should be very high to support modeling efforts..

The large-scale material flammability demonstration will facilitate the understanding of the long-term consequences of a potential spacecraft fire and provide data not only for the verification of detailed numerical models of such an event, but also for the development of predictive models that can assist and optimise fire prevention, response and mitigation.

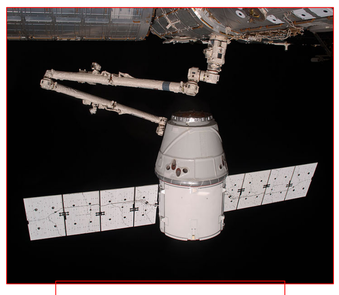
The first step is to provide an appropriate tool that will integrate fire safety into design and management of space vehicles. Such a tool will integrate a wide range of design issues including, but not limited to, material selection, emergency response, crew training, post-fire clean-up, fire detection, fire suppression, environmental control and life support (ECLS) system design, and even atmosphere selection to provide a globally optimised solution.

The Road Ahead

Develop and demonstrate next-generation fire safety instrumentation and predictive tools to guide future spacecraft designers and crew members.

Experiment not performed on ATV-5 – new vessel needed (ATV, HTV)

Orbital – Cygnus?



SpaceX – Dragon?

Larger glove box facility on ISS?

Contact Grunde Jomaas (grujo@byg.dtu.dk) for more information or to express interest in participation.